LeapTrak: Exploring Smartwatch Gestures in 3D

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ABSTRACT

As mobile devices and wearables become smaller and more portable, their development becomes limited in size and hardware capabilities. This leads to difficulties with input as the size of a user's finger can narrow the possible interactions that can be performed or occlude the screen, limiting visual feedback from the device. Inspiring by SoundTrak which presents 3D acoustic sensing techniques for smartwatches, LeapTrak expands upon this previous research through presenting a set of gestures performed in 3D space for smartwatch applications using a Leap Motion [16].

Author Keywords

Smartwatches; Leap Motion; 3D Interaction Techniques; Wearable Computing

INTRODUCTION & MOTIVATION

Due to the sheer size of wearables, it is important for the user's ability to interact with the device's small screen to be taken into account. Researchers have explored issues with users' believing their "fat fingers" get in the way of performing tasks [10]. The issues of fingers occluding visible parts of the screen, preventing the user from receiving visual feedback has also been studied [5]. Moving the interaction space on a smartwatch into 3D space could not only remedy users' finger occlusion problem but also allow for more complex gestures. The set of gestures described in LeapTrak are touch-free, one-handed solutions that expands the screen of a smartwatch into 3D space.

RELATED WORK

Solutions to the Finger Occlusion

Approaches to preventing a user's finger from impairing their view of the screen include expanding the interaction space of a wearable and increasing visibility of the screen to minimize occlusion. On body techniques like TapSkin allow for users to interact with a wearable by tapping the surface on the back of their hand [14]. Another design extends the touchscreen by projecting interactive elements onto the forearm [4]. Touch-free interaction techniques prevent the finger from covering the screen. One method, Whoosh, is a completely hands-free interaction that uses non-voice acoustics such as blowing air into the microphone [8].

Other strategies move the interaction space to behind the screen. BeyondTouch suggests extending the interaction space beyond the limitation of only the front-facing screen to the back of the device by using sensors readily available on a commodity smartphone [15]. Similarly, LucidTouch allows the user to interact behind the device. The system gives the illusion of a semi-transparent screen, preventing the user's fingers from blocking their view [13].

Alternative Input Techniques

PocketTouch employs capacitive touch for eyes-free, multi-touch input through several types of fabrics allowing a user to perform gestures without removing their device from a pocket or handbag [9]. SoundWave uses built-in speakers and microphones to detect interactions such as waving a hand over a device to using the Doppler Effect [1]. Moving into the 2D interaction space, sensing techniques using a magnetic ring and a modified smartwatch can allow for 2D interactions such as rotating, clicking, dragging, and scrolling [3]. Active sonar systems can also be used to support 2D finger interactions [7].

While all of these methods provide alternative input techniques, these methods do not allow for more complex, 3D interaction sets.

Finger Tracking in 3D Space

Devices that can track complex or fine-grained movements in 3D can also be used for finger-tracking. SoundTrak explores an active acoustic sensing technique that enables users to interact with smartwatches in 3D space [16]. OmniTouch is a shoulder-mounted depth-sensing projector system that can detect X, Y, and Z coordinates in addition to whether the user is hovering or clicking [2].

Commercial solutions such as Leap Motion and Microsoft Kinect use computer vision and depth sensors to execute these interactions [12,17]. Projects have applied the finger tracking capabilities of the Leap Motion to monitor stroke patients' rehabilitation through hand recognition and to teach sign language basics through games [6,11]. The Leap Motion's relatively small size and ability to track fingers accurately in 3D space motivated its inclusion in this system.

THE SYSTEM

In the LeapTrak system, the Leap Motion controller would be positioned on the back of the user's hand that is wearing the smartwatch. The user's other hand would be carrying out the following gestures.

Gestures

LeapTrak explores the possibility of adding four additional gestures: point & zoom, expand & contract, rotate, and lock as shown in Figure 1.

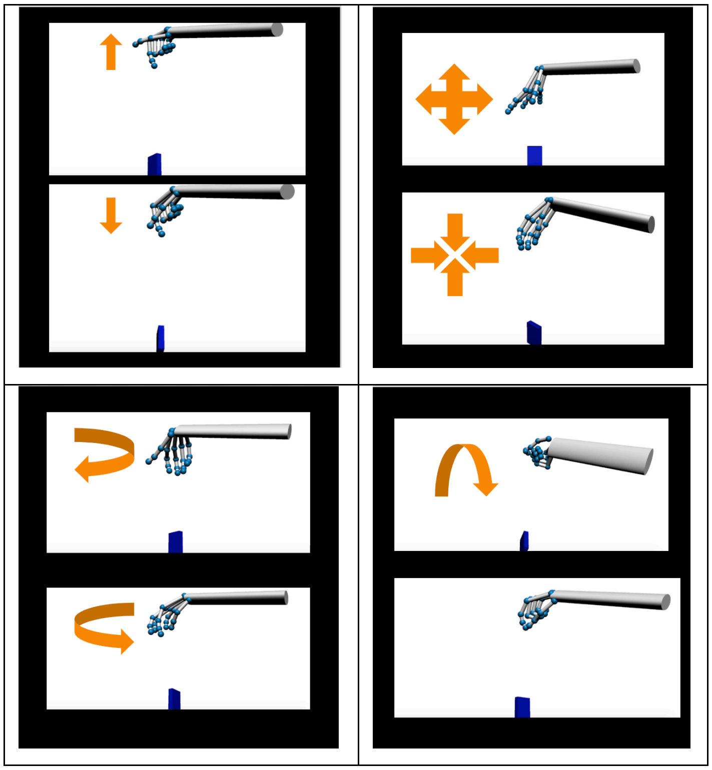

Figure 1. Four LeapTrak Gestures (from left-right, top-down): point & zoom, expand & contract, rotate, lock. Visualized with sample code provided by Leap Motion [18]

The point & zoom gesture consists of the index finger hovering over an object of interest and the thumb sliding up and down to zoom. This gesture could be used for selecting a particular image on a smartwatch screen and zooming in or out. Expand is performed by spreading all five of the fingers widely apart, and contract is conversely done by bringing all five fingers together. The combination could be used for maximizing or minimizing applications. While Leap Motion does have a gesture for circling, it is performed with only the index finger moving in a circle. The proposed rotate gesture would be performed with all five fingers and involve turning the hand as one would on a dial. The movement could be used to change the volume or screen brightness on the smartwatch or to rotate a map or image. The final gesture, lock simulates a user locking a door with a key. The gesture could be used for two factor authentication or for locking the device's screen.

EVALUATION

15 undergraduate students were surveyed about their reactions to the gesture designs. The survey consisted of a demo video showing how a user's hand would interact with the smartwatch while performing the gesture followed by questions regarding the perceived complexity of performing that gesture and perceived usefulness of having the gesture for the applications described earlier.

	Easy to Perform	Usefulness
Point & Zoom	60.00%	73.33%
Expand & Contract	86.67%	86.67%
Rotate	66.67%	80.00%
Lock	66.67%	73.33%

Figure 2. Table showing 15 surveyed users perceived complexity of the gesture set and perceived usefulness of each gesture for its described used case.

As shown in Figure 2, the survey found that 13 of the users believed the expand & contract gesture to be both easy to perform and useful in the described use cases. 12 of the users believed the rotate gesture to be useful but only 10 believed it would be easy to perform. 11 described lock as useful for two factor authentication, and 10 perceived it as easy to perform. Point & zoom was perceived as the most complex gesture, and 11 participants believed it would be useful.

FUTURE WORK

The next step after developing these possible gestures would be conducting a user study with demo applications. While those surveyed provided feedback on their initial reactions to design, their opinions may change after using the device. Data should then be collected on how accurately participants are able to perform gestures, and participants should then be surveyed on their experiences with the system. After this evaluation, an API of possible gestures could be developed and released for future projects.

CONCLUSION

LeapTrak explored the possibility of including 3D gestures on smartwatches. The project included investigating different types of solutions to finger occlusion, the primary motivation behind the study, and alternative interaction techniques. Using the Leap Motion was ultimately decided upon due to its versatility. After developing four gestures, potential users were surveyed about their perceived complexity and usefulness of the gesture. Overall, it was found that a majority of participants surveyed believed each proposed gesture to be easy to perform and useful for its given use case. A more thorough investigation about the possibilities of this gesture set should be carried out in the future.

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